Title: How Much Is Too Much?

Brief Overview:

One of the major problems facing watermen is the over harvesting of species. However, how do they make that determination? How much is too much? There must be a way to estimate population changes. In this unit, students will be informed on how to determine and calculate the population of a species. They will then use statistics and technology in order to make future predictions.

Links to NCTM Standards:

- **Mathematics as Problem Solving**
  Students will calculate the present population of a species using proportions and cross multiplication (Lesson #1).

- **Mathematics as Communication**
  Students will use given data to sketch a scatter plot and create a curve of regression based on this information (Lesson #2).

- **Mathematics as Reasoning**
  Using past and present data, students will predict future populations of species and explain how they reached their conclusions.

- **Mathematical Connections**
  Students will show the mathematical correlation between populations and predator/prey relationships.

- **Algebra**
  Students will generate a regression equation based on a scatter plot for the purpose of future predictions.

- **Statistics**
  Students will be using an estimated total number of crabs from past years to create a scatter plot.

Grade/Level:

Grades 9 and 10

Duration/Length:

Approximately three 50 minute periods

Prerequisite Knowledge:

Students should have working knowledge of the following skills (for example):

- Basic knowledge of graphing calculator
- Solving proportions
- Basic graphing skills
- Concept of predator/prey relationships

Objectives:

Students will:

- be able to use proportions to determine the population of the blue crab.
- be able to analyze gathered data in order to predict outcomes of similar problems.
- be able to show the correlation between occupation and population changes in a particular species.

Materials/Resources/Printed Materials:

- Container
- Blocks or some small item to be sampled (100 - 200 items).
- Stickers
- TI-82 or TI-83 graphing calculators
- Worksheets #1 and #2

Development/Procedures:

In order to complete the previous objectives students will do the following:

1. Perform a class example of capture/recapture to determine the population of a species.
2. Enter given data into a TI-82/TI-83 graphing calculator; create a scatter plot; determine a regression equation; use a table to make future predictions.
3. Discuss and explain predictions as it relates to the given data and to the occupation of a waterman.

Performance Assessment:

Teachers will be able to assess a student's understanding by:

1. Comparing test predictions to known population data.
2. Assessing Worksheets #1 and #2.

Extension/Follow Up:

1. Perform this procedure with different species. (i.e., striped bass).
2. Implement modern technological skills, such as Internet usage.

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Lesson 1: Capture/Recapture

Objective: Students will be able to use proportions in order to determine the population of the blue crab.

Materials: Blocks, Container, Stickers, Calculators, Worksheet #1

Procedures:

• Begin with a discussion on why it is important to know the population of a species, e.g., endangered species, overpopulation, harvest limits, etc.

• Students will now perform an example of capture/recapture to determine how many blocks are in a container. Begin by showing the students how big the block is that will be in the container. Also show them how much of the container is filled with blocks. The students should then make a guess as to how many blocks they think are in the bucket and write it down on a sheet of paper. (The actual number should be greater than 100.)

• Moving around the room, have each student draw between 1 to 3 blocks, depending on the class size. Record how many blocks were "captured". Using stickers or another appropriate marker, have the students tag the blocks and then return them to the bucket.

• Shake or mix the container very well to simulate a species relocating. Then move around the room once again and have the students draw the same number of blocks from the container without looking. When everyone has drawn, count the number of tagged blocks. This is how many were "recaptured".

• To determine the total population of blocks, use the following proportion.

$$\frac{\text{recaptured}}{\text{captured}} = \frac{\text{captured}}{\text{population}}$$

Example : # captured = 40 # recaptured = 14
Actual population = 114

• Repeat the last two steps for a total of three trials, then average the results of the population. Reveal or have the students count the actual number or blocks in the container to see how close the class came. Discussions can follow on whether enough of the blocks were initially captured and how a better estimate could have been made. Now have the students complete Worksheet #1.

Worksheet #1

Now that you know how to determine a population of a species, you have been asked to join a group of scientist who will be trying to find the population of the blue crab. The blue crab lives in over 100,000 acres of the Chesapeake Bay. To try and determine the population, your group has chosen five "1-acre" sites. You then completed a capture/recapture study with the following results. Your job now is to find the population of each site, average the results and then estimate the total population of the Bay.

Site 1: Captured = 950 Recaptured = 104 Population = _____

Site 2: Captured = 425 Recaptured = 61 Population = _____

Site 3: Captured = 1400 Recaptured = 196 Population = _____

Site 4: Captured =1250 Recaptured = 229 Population = _____

Site 5: Captured = 750 Recaptured = 135 Population = _____

Average population of each site = _____

Total population of the Bay = _____

Worksheet #1
Answer Key

Now that you know how to determine a population of a species, you have been asked to join a group of scientist who will be trying to find the population of the blue crab. The blue crab lives in over 100,000 acres of the Chesapeake Bay. To try and determine the population, your group has chosen five "1-acre" sites. You then completed a capture/recapture study with the following results. Your job now is to find the population of each site, average the results and then estimate the total population of the Bay.

Site 1: Captured = 950 Recaptured = 104 Population = 8678

Site 2: Captured = 425 Recaptured = 61 Population = 2961

Site 3: Captured = 1400 Recaptured = 196 Population = 10000

Site 4: Captured =1250 Recaptured = 229 Population = 6823

Site 5: Captured = 750 Recaptured = 135 Population = 4167

Average population of each site = 6526

Total population of the Bay = 652,600,000

Notes: Avg. (8678 + 2961 + 10000 + 6823 + 4167) / 5

Total population = 6526 * 100,000 (# of acres)

Lesson 2: Future Population Studies

Objective: Students will be able to use population statistics in order to generate graphs, equations, and make predictions with a graphing calculator.

Materials: TI-82 or TI-83 Graphing Calculators, Worksheet #2

Procedures:

- In this lesson students will be using statistics based on the actual population of the Chesapeake Bay Blue Crab

- Hand out Worksheet #2 to the students. Using their calculators, students will input the data, create a scatter plot, determine a regression equation of best fit, and then make predictions based on this information.

- *Note to the teacher:* The population data for the blue crabs is not accurate. Data was changed for the purpose of getting a quadratic regression.

- Instructions on how to generate a scatter plot and regression equation:
    1. Clear out **Y=** menu.
    2. Press **STAT**, select **4:Clrlist**, **2nd L1** , **2nd L2**
    3. Press **STAT**, select **1:Edit**
    4. Enter the years under L1 ; Enter the pop. under L2.
    5. Press **2nd STAT PLOT**, select **1:Plot 1**
    6. Turn Plot 1 **On** ; **Type: ∴∵** (first choice) ; **XList: L1** ; **YList : L2**
    7. To view the graph press **ZOOM**, select **9:ZoomStat**.
    8. The scatter plot should look like a parabola.
    9. To get the regression equation y=ax2 + bx + c follow these steps:
    10. Press **STAT**, move right arrow to **CALC**, select **6:QuadReg**.
    11. Press **ENTER**, Press **Y=** , Press **VARS**, select **5: Statistics**.
    12. Move right arrow to **EQ**, select **7:RegEQ**.
    13. Press **GRAPH** (You should now see the scatter plot and curve).
    14. To obtain values for 1998 and 2000 press **2nd TABLE**.

- Teacher Note: The values on the answer sheet are obtained by only using the last two digits of the year, i.e., 1979 = 79, 1998 = 98 , 2000 = 100.

Worksheet #2

Year	Pop. of crabs(in millions)
1986	845
1987	700
1988	585
1989	542
1990	485
1991	420
1992	440
1993	553
1994	600
1995	691

1. Draw a sketch of the scatter plot that you created on the TI.

2. What is the regression equation that best fits the data.

3. Predict the populations for the years 1998 and 2000.

Worksheet #2 (Answer Sheet)

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1. Draw a sketch of the scatter plot that you created on the TI.

2. What is the regression equation that best fits the data.
   y = 15.575757x^2 + -2835.07272x + 129462.33333

3. Predict the populations for the years 1998 and 2000.

   1998 = 1214.8 or 1,214,800,000 crabs
   2000 = 1712.6 or 1,712,600,000 crabs

• After completing this sheet discuss whether this curve was a good model to indicate crab populations. Topics could include harvesting, weather changes, or disease to name just a few. There is no right or wrong answer since crab populations often fluctuate and are very hard to predict.